

1 **SECTION 6-17, PERMANENT GROUND ANCHORS**

2 **April 5, 2004**

3 **6-17.1 Description**

4 This work consists of constructing permanent ground anchors.

6 **6-17.2 Materials**

7 Materials required, including materials for permanent ground anchors, shall be as specified
8 in the Special Provisions.

10 **6-17.3 Construction Requirements**

11 The Contractor shall select the ground anchor type and the installation method, and
12 determine the bond length and anchor diameter. The Contractor shall install ground anchors
13 that will develop the load indicated in the Plans and verified by tests specified in Sections 6-
14 17.3(8)A, 6-17.3(8)B, and 6-17.3(8)C.

16 **6-17.3(1) Definitions**

17 Anchor Devices: The anchorhead wedges or nuts which grip the prestressing steel.

19 Bearing Plate: The steel plate which evenly distributes the ground anchor force to the
20 structure.

22 Bond Length: The length of the ground anchor which is bonded to the ground and transmits
23 the tensile force to the soil or rock.

25 Ground Anchor: A system, referred to as a tieback or as an anchor, used to transfer tensile
26 loads to soil or rock. A ground anchor includes all prestressing steel, anchorage devices,
27 grout, coatings, sheathings and couplers if used.

29 Maintaining Consistency of Load: Maintaining the test load within five percent of the
30 specified value.

32 Minimum Guaranteed Ultimate Tensile Strength (MUTS): The minimum guaranteed
33 breaking load of the prestressing steel as defined by the specified standard.

35 Tendon Bond Length: The length of the tendon which is bonded to the anchor grout.

37 Tendon Unbonded Length: The length of the tendon which is not bonded to the anchor
38 grout.

40 Total Anchor Length: The unbonded length plus the tendon bond length.

42 **6-17.3(2) Contractor Experience Requirements**

43 The Contractor or Subcontractor performing this work shall have installed permanent ground
44 anchors for a minimum of three years. Prior to the beginning of construction, the Contractor
45 shall submit a list containing at least five projects on which the Contractor has installed
46 permanent ground anchors. A brief description of each project and a reference shall be
47 included for each project listed. As a minimum, the reference shall include an individual's
48 name and current phone number.

50 The Contractor shall assign an engineer to supervise the work with at least three years of
51 experience in the design and construction of permanently anchored structures. The

Contractor shall not use consultants or manufacturer's representatives in order to meet the requirements of this section. Drill operators and on-site supervisors shall have a minimum of one year experience installing permanent ground anchors.

Contractors or Subcontractors that are specifically prequalified in Class 36 work will be considered to have met the above experience requirements.

The Contractor shall allow up to 15 calendar days for the Engineer's review of the qualifications and staff as noted above. Work shall not be started on any anchored wall system nor materials ordered until approval of the Contractor's qualifications are given.

6-17.3(3) Submittals

The Contractor shall submit working drawings and structural design calculations in accordance with Section 6-01.9 for the ground anchor system or systems intended for use.

The Contractor shall submit a detailed description of the construction procedure proposed for use to the Engineer for approval.

The Contractor shall submit a ground anchor schedule giving:

1. Ground anchor number
2. Ground anchor design load
3. Type and size of tendon
4. Minimum total bond length
5. Minimum anchor length
6. Minimum tendon bond length
7. Minimum unbonded length

The Contractor shall submit working drawings of the ground anchor tendon and the corrosion protection system. Include details of the following:

1. Spacers and their location
2. Centralizers and their location
3. Unbonded length corrosion protection system, including the permanent rubber seal between the trumpet and the tendon unbonded length corrosion protection.
4. Bond length corrosion protection system
5. Anchorage and trumpet
6. Anchorage corrosion protection system
7. Anchors using non-restressable anchorage devices

The Contractor shall submit shop plans as specified in Section 6-03.3(7) for all structural steel, including the permanent ground anchors to the Engineer for review and approval.

The Contractor shall submit the grout mix designs and the procedures for placing the grout to the Engineer for approval. The Contractor shall also submit the methods and materials used in filling the annulus over the unbonded length of the anchor.

The Contractor shall submit five copies of detailed working drawings in accordance with Section 6-01.9 for the method proposed to be followed for the permanent ground anchor testing to the Engineer for approval prior to the tests. This shall include all necessary drawings and details to clearly describe the method proposed.

1 The Contractor shall submit to the Engineer calibration data for each load cell, test jack,
2 pressure gauge and master pressure gauge to be used. The calibration tests shall have
3 been performed by an independent testing laboratory and tests shall have been performed
4 within 60 calendar days of the date submitted. The Engineer shall approve or reject the
5 calibration data after receipt of the data. Testing shall not commence until the Engineer has
6 approved the load cell, jack, pressure gauge and master pressure gauge calibrations.

7
8 Work shall not begin until the appropriate submittals have been approved in writing by the
9 Engineer.

10 11 **6-17.3(4) Preconstruction Conference**

12 A permanent ground anchor preconstruction conference shall be held at least five working
13 days prior to the Contractor beginning any permanent ground anchor work at the site to
14 discuss construction procedures, personnel, and equipment to be used. The list of materials
15 specified on the Record of Materials Form (ROM) for this item of work will also be discussed.
16 Those attending shall include:

- 17
18 1. (representing the Contractor) The superintendent, on site supervisors, and all
19 foremen in charge of drilling the ground anchor hole, placing the permanent ground
20 anchor and grout, and tensioning and testing the permanent ground anchor.
- 21
22 2. (representing the Contracting Agency) The Project Engineer, key inspection
23 personnel, and representatives from the WSDOT Construction Office and Materials
24 Laboratory Geotechnical Services Branch.

25
26 If the Contractor's key personnel change, or if the Contractor proposes a significant revision
27 of the approved permanent ground anchor installation plan, an additional conference shall
28 be held before any additional permanent ground anchor operations are performed.

29 30 **6-17.3(5) Tendon Fabrication**

31 The tendons can be either shop or field fabricated. The tendon shall be fabricated as shown
32 in the approved shop plans.

33
34 The Contractor shall select the type of tendon to be used. The tendon shall be sized so the
35 design load does not exceed 60 percent of the minimum guaranteed ultimate tensile
36 strength of the tendon. In addition, the tendon shall be sized so the maximum test load does
37 not exceed 80 percent of the minimum guaranteed ultimate tensile strength of the tendon.

38
39 The Contractor shall be responsible for determining the bond length and tendon bond length
40 necessary to develop the design load indicated in the Plans in accordance with Sections 6-
41 17.3(8)A, 6-17.3(8)B, and 6-17.3(8)C. The minimum bond length shall be ten feet in rock
42 and 15 feet in soil.

43
44 When the Plans require the tendon bond length to be encapsulated, the tendon bond length
45 portion of the tendon shall be corrosion protected by encapsulating the tendon in a grout-
46 filled PE or PVC tube as specified in Section 6-17.2 as supplemented in the Special
47 Provisions. The tendons can be grouted inside the encapsulation prior to inserting the
48 tendon in the drill hole or after the tendon has been placed in the drill hole. Expansive
49 admixtures can be mixed with the encapsulation grout if the tendon is grouted inside the
50 encapsulation while outside the drill hole. The tendon shall be centralized within the bond
51 length encapsulation with a minimum of 0.20 inches of grout cover. Spacers shall be used

1 along the tendon bond length of multi-element tendons to separate the elements of the
2 tendon so the prestressing steel will bond to the encapsulation grout.
3

4 Centralizers shall be used to provide a minimum of 0.5 inches of grout cover over the tendon
5 bond length encapsulation. Centralizers shall be securely attached to the encapsulation and
6 the center-to-center spacing shall not exceed ten feet. In addition, the upper centralizer
7 shall be located a maximum of five feet from the top of the tendon bond length and the lower
8 centralizer shall be located a maximum of one foot from the bottom of the tendon bond
9 length.
10

11 The centralizer shall be able to support the tendon in the drill hole and position the tendon so
12 a minimum of 0.5 inches of grout cover is provided and shall permit free flow of grout.
13

14 Centralizers are not required on encapsulated, pressure-injected ground anchor tendons if
15 the ground anchor is installed in coarse grained soils (more than 50 percent of the soil larger
16 than the number 200 sieve) using grouting pressures greater than 150 psi.
17

18 Centralizers are not required on encapsulated, hollow-stem-augered ground anchor tendons
19 if the ground anchor is grouted through and the hole is maintained full of a stiff grout (eight-
20 inch slump or less) during extraction of the auger.
21

22 The minimum unbonded length of the tendon shall be the greater of 15 feet or that indicated
23 in the Plans.
24

25 Corrosion protection of the unbonded length shall be provided by a sheath completely filled
26 with corrosion inhibiting grease or grout. If grease is used under the sheath, provisions shall
27 be made to prevent the grease from escaping at the ends of the sheath. The grease shall
28 completely coat the tendon and fill the voids between the tendon and the sheath. The
29 working drawings shall show how the Contractor will provide a transition between the tendon
30 bond length and the unbonded tendon length corrosion protection.
31

32 If the sheath is not fabricated from a smooth tube, a separate bondbreaker shall be
33 provided. The bondbreaker shall prevent the tendon from bonding to the anchor grout
34 surrounding the tendon unbonded length.
35

36 The total anchor length shall not be less than that indicated in the Plans or the approved
37 working drawings.
38

39 Anchorage devices shall be capable of developing 95 percent of the minimum guaranteed
40 ultimate tensile strength of the prestressing steel tendon. The anchorage devices shall
41 conform to the static strength requirements of Section 3.1 of the Post Tensioning Institute
42 "Specification for Unbonded Single Strand Tendons, First Edition - 1993".
43

44 Non-restressable anchorage devices may be used except where indicated in the Plans.
45

46 Restressable anchorages shall be provided on those ground anchors that require reloading.
47 The post-tensioning supplier shall provide a restressable anchorage compatible with the
48 post-tensioning system provided.
49

50 The bearing plates shall be sized so the bending stresses in the plate do not exceed the
51 yield strength of the steel when a load equal to 95 percent of the minimum guaranteed
52 ultimate tensile strength of the tendon is applied, and the average bearing stress on the

concrete does not exceed that recommended in Section 3.1.3 of the Post Tensioning Institute, "Specification For Unbonded Single Strand Tendons, First Edition - 1993".

The trumpet shall have an inside diameter equal to or larger than the hole in the bearing plate. The trumpet shall be long enough to accommodate movements of the structure during testing and stressing. For strand tendons with encapsulation over the unbonded length, the trumpet shall be long enough to enable the tendon to make a transition from the diameter of the tendon in the unbonded length to the diameter of the tendon at the anchorhead without damaging the encapsulation. Trumpets filled with corrosion-inhibiting grease shall have a permanent rubber seal, as approved by the Engineer, provided between the trumpet and the tendon unbonded length corrosion protection. Trumpets filled with grout shall have a temporary seal provided between the trumpet and the tendon unbonded length corrosion protection or the trumpet shall overlap the tendon unbonded length corrosion protection.

6-17.3(6) Tendon Storage And Handling

Tendons shall be handled and stored in such a manner as to avoid damage or corrosion. Damage to the prestressing steel as a result of abrasions, cut, nicks, welds and weld splatter will be cause for rejection by the Engineer. The prestressing steel shall be protected if welding is to be performed in the vicinity. Grounding of welding leads to the prestressing steel is forbidden. Prestressing steel shall be protected from dirt, rust, and deleterious substances. A light coating of rust on the steel is acceptable. If heavy corrosion or pitting is noted, the Engineer will reject the affected tendons.

The Contractor shall use care in handling and storing the tendons at the site. Prior to inserting a tendon in the drill hole, the Contractor and the Engineer will examine the tendon for damage to the encapsulation and the sheathing. If, in the opinion of the Engineer, the encapsulation is damaged, the Contractor shall repair the encapsulation in accordance with the tendon supplier's recommendations and as approved by the Engineer. If, in the opinion of the Engineer, the smooth sheathing has been damaged, the Contractor shall repair it with ultra high molecular weight polyethylene (PE) tape. The tape shall be spiral wound around the tendon so as to completely seal the damaged area. The pitch of the spiral shall ensure a double thickness at all points.

6-17.3(7) Installing Permanent Ground Anchors

The Contractor shall select the drilling method, the grouting procedure, and the grouting pressure used for the installation of the ground anchor.

When caving conditions are encountered, no further drilling will be allowed until the Contractor selects a method to prevent ground movement. The Contractor may use a temporary casing. The Contractor's method to prevent ground movement shall be approved by the Engineer. The casings for the anchor holes, if used, shall be removed. The drill hole shall be located so the longitudinal axis of the drill hole and the longitudinal axis of the tendon are parallel. The ground anchor shall not be drilled in a location that requires the tendon to be bent in order to enable the bearing plate to be connected to the supported structure. At the point of entry the ground anchor shall be installed within plus or minus three degrees of the inclination from horizontal shown in the Plans or the approved working drawings. The ground anchors shall not extend beyond the right of way limits.

The tendon shall be inserted into the drill hole to the desired depth. When the tendon cannot be completely inserted without difficulty, the Contractor shall remove the tendon from the drill hole and clean or redrill the hole to permit insertion. Partially inserted tendons shall not be driven or forced into the hole.

1
2 The Contractor shall use a grout conforming to Section 6-17.2 as supplemented in the
3 Special Provisions.

4
5 The grout equipment shall produce a grout free of lumps and undispersed cement. A
6 positive displacement grout pump shall be used. The pump shall be equipped with a
7 pressure gauge near the discharge end to monitor grout pressures. The pressure gauge
8 shall be capable of measuring pressures of at least 150 psi or twice the actual grout
9 pressures used by the Contractor, whichever is greater. The grouting equipment shall be
10 sized to enable the grout to be pumped in one continuous operation. The mixer shall be
11 capable of continuously agitating the grout.

12
13 The grout shall be injected from the lowest point of the drill hole. The grout may be pumped
14 through grout tubes, casing, or drill rods. The grout can be placed before or after insertion of
15 the tendon. The quantity of the grout and the grout pressures shall be recorded. The grout
16 pressures and grout takes shall be controlled to prevent excessive heave in soils or
17 fracturing of rock formations.

18
19 After grouting, the tendon shall not be loaded for a minimum of 3 days.

20
21 No grout shall be placed above the top of the bond length during the time the bond length
22 grout is placed. The grout at the top of the drill hole shall not contact the back of the
23 structure or the bottom of the trumpet. Except as otherwise noted, only nonstructural filler
24 shall be placed above the bond length grout prior to testing and acceptance of the anchor.
25 The Contractor may place structural grout above the bond length grout prior to testing and
26 acceptance of the anchor subject to the following conditions:

- 27
28 1. The anchor unbonded length shall be increased by eight feet minimum.
29
30 2. The grout in the unbonded zone shall not be placed by pressure grouting methods.
31

32 The corrosion protection surrounding the unbonded length of the tendon shall extend up
33 beyond the bottom seal of the trumpet or one foot into the trumpet if no trumpet seal is
34 provided. If the protection does not extend beyond the seal or sufficiently far enough into
35 the trumpet, the Contractor shall extend the corrosion protection or lengthen the trumpet.

36
37 The corrosion protection surrounding the no load zone length of the tendon shown in the
38 Plans shall not contact the bearing plate or the anchorhead during testing and stressing. If
39 the protection is too long, the Contractor shall trim the corrosion protection to prevent
40 contact.

41
42 The bearing plate and anchorhead shall be placed so the axis of the tendon and the drill
43 hole are both perpendicular to the bearing plate within plus or minus three degrees and the
44 axis of the tendon passes through the center of the bearing plate.

45
46 The trumpet shall be completely filled with corrosion inhibiting grease or grout. Trumpet
47 grease can be placed anytime during construction. Trumpet grout shall be placed after the
48 ground anchor has been tested. The Contractor shall demonstrate to the Engineer that the
49 procedure selected by the Contractor for placement of either grease or grout produces a
50 completely filled trumpet.
51

1 All anchorages permanently exposed to the atmosphere shall be covered with a corrosion
2 inhibiting grease-filled or grout-filled cover. The Contractor shall demonstrate to the
3 Engineer that the procedures selected by the Contractor for placement of either grease or
4 grout produces a completely filled cover. If the Plans require restressable anchorages,
5 corrosion inhibiting grease shall be used to fill the anchorage cover and trumpet.
6

7 **6-17.3(8) Testing And Stressing**

8 Each ground anchor shall be tested. The test load shall be simultaneously applied to the
9 entire tendon. Stressing of single elements of multi-element tendons will not be permitted.
10 Test data will be recorded by the Engineer.
11

12 The testing equipment shall consist of a dial gauge or vernier scale capable of measuring to
13 0.001 inches shall be used to measure the ground anchor movement. The movement-
14 measuring device shall have a minimum travel equal to the theoretical elastic elongation of
15 the total anchor length plus 1 inch. The dial gauge or vernier scale shall be aligned so that
16 its axis is within 5 degrees from the axis of the tieback. A hydraulic jack and pump shall be
17 used to apply the test load. The jack and pressure gauge shall be calibrated by an
18 independent testing laboratory as a unit. Each load cell, test jack and pressure gauge, and
19 master pressure gauge, shall be calibrated as specified in Section 6-17.3(3). Additionally,
20 the Contractor shall not use load cells, test jacks and pressure gauges, and master pressure
21 gauges, greater than 60 calendar days past their most recent calibration date, until such
22 items are re-calibrated by an independent testing laboratory.
23

24 The pressure gauge shall be graduated in 100-psi increments or less. The pressure gauge
25 will be used to measure the applied load. The pressure gauge shall be selected to place the
26 maximum test load within the middle two-thirds of the range of the gauge. The ram travel of
27 the jack shall not be less than the theoretical elastic elongation of the total anchor length at
28 the maximum test load plus one inch. The jack shall be independently supported and
29 centered over the tendon so that the tendon does not carry the weight of the jack. The
30 Contractor shall have a second calibrated jack pressure gauge at the site. Calibration data
31 shall provide a specific reference to the jack and the pressure gauge.
32

33 The loads on the tiebacks during the performance and verification tests shall be monitored to
34 verify consistency of load as defined in Section 6-17.3(1). Test loads less than 20,000
35 pounds shall be monitored by the jack pressure gauge. Test loads equal to or greater than
36 20,000 pounds shall be monitored with an electric or hydraulic load cell. The Contractor
37 shall provide the load cell and a readout device. The load cell shall be selected to place the
38 maximum test load within the middle two-thirds of the range of the load cell. The stressing
39 equipment shall be placed over the ground anchor tendon in such a manner that the jack,
40 bearing plates, load cell and stressing anchorage are in alignment.
41

42 **6-17.3(8)A Verification Testing**

43 Verification tests shall be performed to verify the design of the anchor system. These
44 ground anchor test results shall verify the Contractor's design and be approved by the
45 Engineer prior to ordering anchor material for the tieback retaining walls. The tests shall be
46 performed on sacrificial test anchors. A minimum of two successful verification tests shall be
47 conducted. The locations shall be close to the anchor location of the production anchors.
48 The test locations shall be selected by the Contractor and approved by the Engineer.
49

50 The drilling method, anchor diameter, and depth of anchorage for the test anchor shall be
51 identical as for the production anchors. The no-load zone shall be backfilled prior to
52 withdrawing the casing.

The anchor tested shall be loaded to 200 percent of the design load (DL). The prestressing tendon shall be proportioned such that the maximum stress does not exceed 80 percent of the ultimate strength of the steel. The jack shall be positioned at the beginning of the test such that unloading and repositioning of the jack during the test will not be required.

The verification tests shall be made by incrementally loading the anchors in accordance with the following schedule.

AL - Anchor Alignment Load

DL - Anchor Design Load

Load	Hold Time
AL	1 Min.
0.25DL	10 Min.
0.50DL	10 Min.
0.75DL	10 Min.
1.00DL	10 Min.
1.25DL	10 Min.
1.50DL	60 Min.
1.75DL	10 Min.
2.00DL	10 Min.
AL	1 Min.

The test load shall be applied in increments of 25 percent of the design load. Each load increment shall be held for at least 10 minutes. Measurement of anchor movement shall be obtained at each load increment. The load-hold period shall start as soon as the test load is applied and the anchor movement, with respect to a fixed reference, shall be measured and recorded at 1 minute, 2, 3, 4, 5, 6, 10, 15, 20, 25, 30, 45, and 60 minutes.

The verification test will be considered successful if the anchor meets the criteria for a performance tested ground anchor in Section 6-17.3(9), and in addition, a pull-out failure does not occur at the 2.0DL maximum load.

The Engineer will give the Contractor a written order concerning ground anchor construction within seven working days after completion of the verification tests. This written order will either confirm the bond lengths as shown in the Contractor's plans for ground anchors or reject the anchors based upon the result of the verification tests.

6-17.3(8)B Performance Testing

Performance tests shall be done in accordance with the following procedures. Five percent of the ground anchors or a minimum of three ground anchors, whichever is greater, shall be performance tested. The Engineer shall select the ground anchors to be performance tested. The first production anchor shall be performance tested.

The performance test shall be made by incrementally loading and unloading the ground anchor in accordance with the following schedule. The load shall be raised from one increment to another immediately after a deflection reading.

Performance Test Schedule

1	Load	Load
2		
3	AL	AL
4	0.25DL	0.25DL
5	AL	0.50DL
6	0.25DL	0.75DL
7	0.50DL	1.00DL
8	AL	1.25DL
9	0.25DL	AL
10	0.50DL	0.25DL
11	0.75DL	0.50DL
12	AL	0.75DL
13	0.25DL	1.00DL
14	0.50DL	1.25DL
15	0.75DL	1.50DL
16	1.00DL	AL
17		Jack to lock-off load

18
19 Where: AL - is the alignment load DL - is the anchor design load.

20
21 The maximum test load in a performance test shall be held for ten minutes. The load-hold
22 period shall start as soon as the maximum test load is applied and the anchor movement,
23 with respect to a fixed reference, shall be measured and recorded at 1 minute, 2, 3, 4, 5, 6,
24 and 10 minutes. If the anchor movement between one minute and ten minutes exceeds
25 0.04 inches, the maximum test load shall be held for an additional 50 minutes. If the load
26 hold is extended, the anchor movement shall be recorded at 15 minutes, 20, 25, 30, 45, and
27 60 minutes. If an anchor fails in creep, retesting will not be allowed. All anchors not
28 performance tested shall be proof tested.

29 30 **6-17.3(8)C Proof Testing**

31 Proof tests shall be performed by incrementally loading the ground anchor in accordance
32 with the following schedule. The load shall be raised from one increment to another
33 immediately after a deflection reading. The anchor movement shall be measured and
34 recorded to the nearest 0.001 inches with respect to an independent fixed reference point at
35 the alignment load and at each increment of load. The load shall be monitored with a
36 pressure gauge. At load increments other than the maximum test load, the load shall be
37 held just long enough to obtain the movement reading.

38 39 **Proof Test Schedule**

40		
41	Load	Load
42		
43	AL	1.00DL
44	0.25DL	1.25DL
45	0.50DL	1.50DL
46	0.75DL	Jack to lock-off load

47
48 Where: AL - is the alignment load
49 DL - is the anchor design load

50
51 The maximum test load in a proof test shall be held for ten minutes. The load-hold period
52 shall start as soon as the maximum test load is applied and the anchor movement with

respect to a fixed reference shall be measured and recorded at 1 minute, 2, 3, 4, 5, 6, and 10 minutes. If the anchor movement between one minute and ten minutes exceeds 0.04 inches, the maximum test load shall be held of an additional 50 minutes. If the load hold is extended, the anchor movements shall be recorded at 15 minutes, 20, 25, 30, 45, and 60 minutes. If an anchor fails in creep, retesting will not be allowed.

6-17.3(9) Permanent Ground Anchor Acceptance Criteria

A performance or proof tested ground anchor with a ten minute load hold is acceptable if the:

1. Ground anchor carries the maximum test load with less than 0.04 inches of movement between one minute and ten minutes; and
2. Total movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the tendon unbonded length.

A verification, performance or proof tested ground anchor with a 60-minute load hold is acceptable if the:

1. Ground anchor carries the maximum test load with a creep rate that does not exceed 0.08 inches/log cycle of time and is a linear or decreasing creep rate.
2. Total movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the tendon unbonded length.

If the total movement of the ground anchors at the maximum test load does not exceed 80 percent of the theoretical elastic elongation of the tendon unbonded length, the Contractor shall replace the ground anchor at no additional cost to the Contracting Agency. Retesting of a ground anchor will not be allowed.

Ground anchors which have a creep rate greater than 0.08 inches/log cycle of time can be incorporated in the finished work at a load equal to one-half its failure load. The failure load is the load carried by the anchor after the load has been allowed to stabilize for ten minutes.

When a ground anchor fails, the Contractor shall modify the design, the construction procedures, or both. These modifications may include, but are not limited to, installing replacement ground anchors, modifying the installation methods, increasing the bond length or changing the ground anchor type. Any modification which requires changes to the structure shall have prior approval of the Engineer. Any modifications of design or construction procedures shall be at the Contractor's expense.

Upon completion of the test, the load shall be adjusted to the lock-off load indicated in the Plans and transferred to the anchorage device. The ground anchor may be completely unloaded prior to lock-off. After transferring the load and prior to removing the jack a lift-off reading shall be made. The lift-off reading shall be within ten percent of the specified lock-off load.

If the load is not within ten percent of the specified lock-off load, the anchorage shall be reset and another lift-off reading shall be made. This process shall be repeated until the desired lock-off load is obtained.

1 **6-17.4 Measurement**

2 Permanent ground anchors will be measured per each for each permanent ground anchor
3 installed and accepted.

4
5 Permanent ground anchor performance tests will be measured per each for each anchor
6 performance tested.

7
8 The permanent ground anchor verification testing program will not be measured but will be
9 paid for on a lump sum basis.

10

11 **6-17.5 Payment**

12 Payment will be made in accordance with Section 1-04.1 for each of the following bid items
13 when they are included in the proposal:

14

15 "Permanent Ground Anchor", per each.

16 All costs in connection with furnishing and installing permanent ground anchors shall be
17 included in the unit contract price per each for "Permanent Ground Anchor", including
18 proof testing of the installed anchor as specified.

19

20 "Permanent Ground Anchor Performance Test", per each.

21 "Permanent Ground Anchor Verification Test", lump sum.